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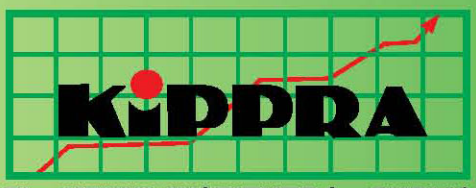

The KENYA INSTITUTE for PUBLIC POLICY RESEARCH and ANALYSIS

Empirical Estimation of Productivity and its Determinants in Kenya

Diana Lukalo and Felix Kiminyei

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THE KENYA INSTITUTE FOR PUBLIC POLICY RESEARCH AND ANALYSIS (KIPPRA)

YOUNG PROFESSIONALS (YPs) TRAINING PROGRAMME

Empirical Estimation of Productivity and its Determinants in Kenya

Diana Lukalo and Felix Kiminyei

Kenya Institute for Public Policy
Research and Analysis

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Abstract

The Republic of Kenya has put labour productivity among its key objectives since independence. Studying labour productivity can have strong implications for economic growth and welfare. This study sought to contribute to this national objective. Specifically, the study objectives were to estimate total factor productivity; labour productivity for the economy and at the sectors; and factors affecting economy labour productivity for the period 2000-2016. Data was obtained from the Kenya National Bureau of Statistics economic surveys and international data sources including United Nations Development Programme, the International Labour Organization employment database and World Bank. For total factor productivity, the approach used is close to the one proposed by Solow and Swan where the residue is estimated with the aid of a Cobb Douglas production function restricted to constant returns to scale, while the conventional approach of using the ratio of gross value added to number of persons working is used to estimate labour productivity. An ordinary Least Square estimation is used to estimate the factors that determine labour productivity. In the estimation of total factor productivity, the elasticity of labour is 0.86 while the elasticity of capital is 0.14. When total factor productivity is included, the elasticity of labour is 0.62 while that of capital is 0.38. The results also indicate that total factor productivity rose about 10 per cent while the labor productivity rose to 27 per cent in the study period. At the sectoral level, it is apparent that the services industry has a fairly higher output per person followed closely by manufacturing industry. In this segment, the economy labour productivity is used as the baseline. In the services industry, the real estate followed by fairly well with their labour productivity about 97 and 13 times the economy average. In the manufacturing industry, the utilities sector dominates with labour productivity about 11 times the economy average as of 2016. The agriculture industry has the lowest labor productivity with the agriculture and mining sectors being 1.8 times and 0.4 times the economy average, respectively. Some of the factors affecting labour productivity include education, technology, wages, capital intensity, macroeconomic stability, openness, and government expenditure, and participation rate. In particular, one year increase in education increases labour productivity by 10 per cent. A one per cent increase in openness reduces labour productivity by 0.01 per cent suggesting that liberalization may not be benefiting Kenya due to competition from cheap imports, owing to cheap labour and low domestic value addition. Similarly, an increase in the labour participation rate by 1 unit reduces labour productivity by 0.03 per cent, suggesting that greater labour market participation brings in the less productive persons. The study recommends that intervention in the education system is necessary to ensure quality across the system. This can involve a combination of investment of public

resources – to fund areas in which there is market failure, and ensure equity. In addition, incentives for individual educators to focus on teaching excellence are important in improving quality. Secondly, there is need to develop a patent information policy, and cut down on lengthy procedures and costs associated with patent application to create a conducive environment for innovation - that will protect ideas of innovators and spur uptake of new technologies.

Abbreviations and Acronyms

GVA	Gross Value Added
ILO	International Labour organization
K	Capital
KNBS	Kenya National Bureau of Statistics
L	Labour
LP	Labour Productivity
MFP	Multi-Factor Productivity
PCK	Productivity Centre of Kenya
QALI	Quality-Adjusted Labour Input
TFP	Total Factor Productivity
VICS	Volume Index of Capital Services

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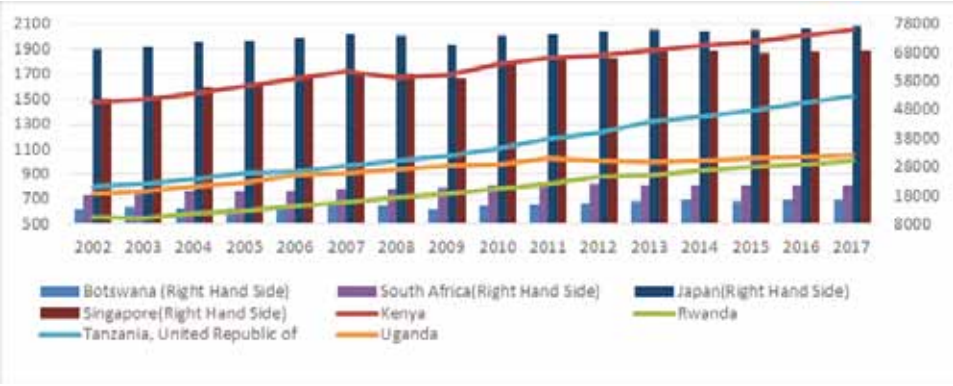
1. Introduction

The Kenya National Productivity Policy 2013 posits that for the country to achieve the Vision 2030 aspirations of upper middle-income status and reduce youth unemployment, Labour Productivity Index should be raised from 2.0 to 4.0. Figure 1.1 shows that Kenya's labour productivity has improved over time. Although performing better than other countries in the EAC region, it remains below the East Asia Tigers. The most direct mechanism through which labour productivity affects living standards is through real wages. As such, labour productivity is associated with economic prosperity, enhanced standards of living and quality of life and competitiveness (Freeman, 2008).

Figure 1.1: Output per worker (GDP constant 2005 US $)



Source of data: ILO modelled estimates

The Kenya Government has continued to emphasize on the role of productivity in promoting global competitiveness, achieving high and sustained economic growth and durable employment opportunities. As a result, the Wage Guidelines, the Sessional Paper No. 1 of 1986, the 7th National Development Plan framework (1997-2001), the Economic Recovery Strategy for Wealth and Employment Creation (2003-2007), the Kenya Vision 2030 and the Medium-Term Plan I and II recognize the importance of incorporating productivity gain in wage determination. Further, through Sessional Paper No. 3 of 2013 on National Productivity Policy, a National Productivity Council (NPC) was established to drive the public and private sector efforts in enhancing implementation of productivity improvement programmes and offer policy advice to the Government (Government of Kenya, 2013a).

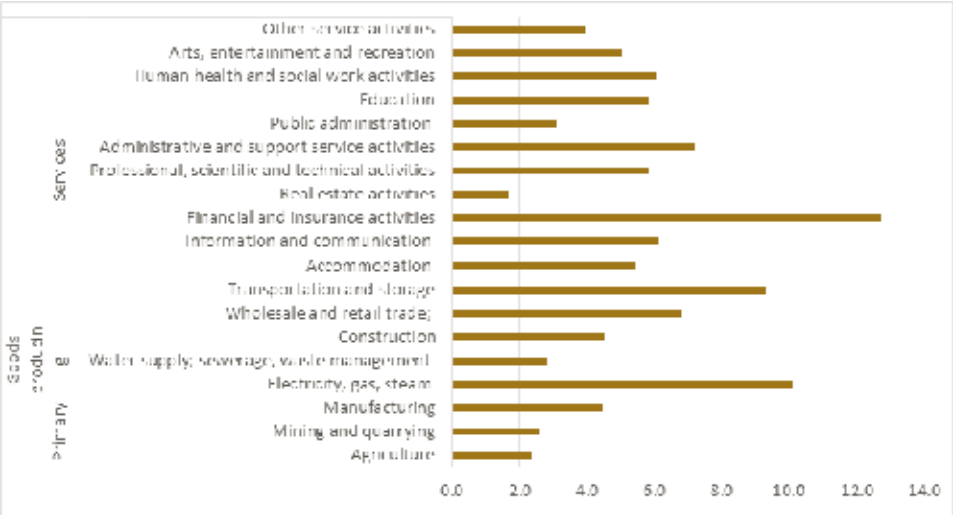
Notwithstanding these efforts, the country is still held in a low productivity trap manifested by low purchasing power, low capacity utilization, limited capital formation, rising domestic prices and unit costs, and spiral agitation for wage

increments. Further, the country has continually experienced prevalence of high levels of unemployment especially among the youth. According to the Labour Force Basic Report 2015/16, while the youth accounts for nearly 55.3 per cent of the labour force, unemployment among this segment is estimated at 47.7 per cent, which is higher than the overall unemployment estimated at 7.4 per cent. This reflects the economy's inability to create adequate productive jobs to meet ballooning youthful population transitioning from the learning institutions across the country.

In 2016, Kenya's labour force was estimated at 16 million workers, of which almost 62 per cent worked in agriculture and mining while 7 per cent worked in manufacturing, construction and utilities and the rest under services (Kenya National Bureau of Statistics, 2017). The informal sector absorbed the highest number of employed persons at 13.31 million persons, with the wholesale and retail trade, hotels and restaurants accounting for 59.7 per cent of total informal employment while 20.4 per cent were in the manufacturing industry. The informal sector jobs are vulnerable as returns are uncertain and take the form of self-employment and family businesses. While agriculture is the largest employer in the formal sector, jobs are mainly in smallholder and subsistence farming and with low earnings. Figures 1.2 and 1.3, for example, show that financial and insurance services have over the years recorded the highest share of earnings while agriculture and forestry had the lowest. It is argued that firms either pay higher wages to stimulate productivity or take a more active role of rewarding higher productivity by paying higher wages (Millea, 2012).

Figure 1.2: Share of earnings in total earnings 2000-2008 (%)

Figure 1.3: Share of earnings in total earnings 2008-2016 (%)



Various factors impact on labour productivity. These include: poor work attitudes and ethics, non-conducive work environment, low adoption of productivity enhancing tools, and poor labour management (Government of Kenya, 2013b). Therefore, Kenyan workers are predominantly locked into low productivity jobs and sectors. In the US, India, Singapore, Indonesia, Thailand, Turkey and Iran, the important factors affecting labour productivity are supervision, skill of labour, absenteeism, tools and equipment and financial constraints.

Labour productivity is used to establish the ability of an economy to create and sustain decent employment opportunities and fair and equitable remuneration (Government of Kenya, 2013a). As such, this study examines labour productivity in Kenya in supporting efforts to improve competitiveness, welfare, and create highly productive jobs across the different sectors of the economy. Using secondary data across various sectors, the study defines labour productivity as the ratio of real GDP to the total labour force.

The rest of the study is organized as follows: chapter two presents a review of both theories and empirical literature while chapter three highlights the methodology that will be used to achieve the objectives of the study. Chapter four gives a chronology of the analysis while chapter five gives a summary, conclusion and recommendations.

2. Literature Review

2.1 Measurement of Productivity

There is currently no consensus on the definition of productivity. The definition used depends on the variables at hand. Existing approaches consider the efficiency with which some input is used to produce output. In general, every measure of productivity is a ratio of output to inputs. Three general measures of productivity exist: Total factor productivity (TFP), partial productivity, and total productivity.

Total factor productivity (TFP), also called the multifactor productivity (MFP), measures the efficiency in the use of capital and labour inputs. As in equation 2.1, it can also be defined as that proportion of output unexplained by the volume of inputs employed in production, where *K* refers to capital inputs. The production functions with labour and capital as sole inputs is captured as *(F(K,L)*, the denominator in equation 2.1.

Multifactor Productivity (MFP)=Q/F(K,L) *2.1*

Usually, it is captured as the percentage increase in output unaccounted for by changes in volume of capital and labour inputs. An advantage of TFP over labour productivity is that it closely approximates an economy's return on capital. Second, when TFP is used for comparison between countries, it is less affected by national differences of computing real output. Notwithstanding this advantage, TFP compared to labour productivity is difficult to measure owing to a variety of methods in valuation of a nation's capital stock that yield divergent results (Carnaje, 2013).

Partial productivity is the efficiency with which a specific input is used to produce output. Examples include partial factor productivity for labour or capital as presented in 2.2 and 2.3, where, is output, is labour units and K is capital inputs.

Labour productivity=Q/L *2.2*

Capital productivity=Q/K *2.3*

The partial productivity has been criticized on grounds that increase in output may stem from increases in other inputs, since the output is not disaggregated during its computation. In this context, a firm may increase labour productivity ratio by introducing an efficient equipment which increases it output without reducing its labour employment. In short, partial productivity measures do not incorporate the role of capital-labour substitution.

Total productivity, on the other hand, is a comprehensive concept, given that by definition it is the aggregate output divided over total input in production of output. At the firm, to eliminate inflation effects, the amount of output and inputs is expressed in monetary values. In this case, the quantity of outputs and inputs are expressed in

deflated currency units, making total productivity immeasurable in practice. Thus, only changes in total productivity are measured (Hannula, 2002).

2.1.1 Measures of output and input

Consistent estimates of inputs and outputs are necessary to come up with quality estimates of productivity. Aggregate output, gross domestic product (GDP), or gross value added (GVA) may be used as a measure of output. Total output measures total production and is computed as the monetary value of sales added to the additional inventory value of finished goods (Office for National Statistics, 2007). On the other hand, GDP and GVA, which are net of inputs used, equal production value minus intermediate inputs value. Sometimes, sales are used but it is not a proper measure of production because it may exclude large amounts of inventory and understate output. However, at the firm level, gross output is the best measure of output since firms attempt to use inputs efficiently. At an aggregate level, value added is used to avoid double counting (Grossman., 1984).

For labour productivity, input means labour input such as number of employees or hours worked while for MFP, input refers to both capital and labour. Usually, the input measures are volume index of capital services (VICS) and measures of quality-adjusted labour input (QALI). QALI adopts hours worked as labour's input in production and approximates the marginal productivity of workers, and adjusting hours worked using their characteristics. These measures are seen to yield accurate estimates of productivity growth as they incorporate improvements in inputs.

From analysis of production, the input of labour is best captured by aggregate worked hours rather than head count of the employees when variations in quality are ignored. The reason advanced is that headcounts do not reveal changes in average hours worked, owing to changes of variations in overtime, part-time employment, and shifts during usual working hours.

A number of measurement issues regarding capturing of actual working hours arise, including statistical sources available, and surveys on households. Significant variations arise in computing hours worked versus full-time persons, making confidence in international comparison uncertain (OECD, 2001).

Capital goods employed by a firm have capital services which comprise the real input in process of production while the real carriers of the services of labour are the persons employed over time. Owing to the fact that producers are the owners of capital goods, variations arise among capital and labour. One challenge in measuring capital is the measurement of implicit transactions of capital services, since no market transaction is recorded when capital delivers services to the owner, yet user costs of capital exist (OECD, 2001). Secondly, the nature of capital and its role in the production process

has elicited a continuing debate where on one part emphasis is laid on prices and the volumes of capital services while on the other, the services not of capital good but rather the opportunity cost of future consumption- is essential (Rymes, 1971).

2.2 Theoretical Literature

2.2.1 Ricardian (classical) Theory

This theory was proposed by David Ricardo in 1817. It was based on two principles: "marginal principle" that explains the share of rent and the "surplus principle" explaining the subdivision of the residue into wages and profits. In this theory, the economy is assumed to have two aggregate sectors: agriculture and industry. Thus, distribution in the industry is influenced by those forces in play in the agricultural sector where it is assumed that the average and marginal products for labour follow the law of diminishing marginal returns. Output is determined uniquely when the quantity of labour for any given working population is given. The difference between average and marginal productivity of labour, which is the definition of rent, relies on the response of the average product of labour which is the degree which diminishing returns operate.

According to the Ricardian theory, wages added to profits equals the marginal product of labour, which is in contrast to the ideas of the marginalist theory of productivity. The price at which labour is supplied determines the wage rate, which is assumed constant and independent of marginal productivity. It is worth noting that Ricardo was analyzing production of corn, with the theory implying that for a given price for supply, the labour supply curve was infinitely elastic.

The accumulation of capital and not the marginal product of labour determines the demand for labour (Kaldor, 1955-1956). Equilibrium is reached at the point where the aggregate demand for labour intersects with the "wages fund". Wages fund was defined to imply that wages were paid out of and relied on capital, and labourers could not wait for their wages to be paid by the capitalists since the production process took time. As capital accumulates, labour force grows and any increase to the wage fund, through accumulation of capital, pushes the wages outwards to the right. Profits were viewed as a residue for a certain employment level as the difference between the marginal product of labour and the wages rate. In tandem, profits to wages ratio influence the rate of profit on the capital used. Thus, at equilibrium, the money rate of profit per cent from capital remains the same in agriculture and industry, as capital is transferred from one use employment to another. Capital would move from one form of employment to the other, at equilibrium, such that the money rate of profit per cent from capital will be the same in industry and in agriculture. Agriculture was considered more productive than industry and industry could improve productivity

by making prices of its manufactured output more dear for output from agriculture to be at similar level with industry. Declining profit in agriculture was attributed to diminishing fertility of the soil (Machlup, 1955).

2.2.2 Marxian Theory

The Marxian theory makes the assumption that, at any given time, labour supply in wage-employment exceeds available opportunities. There exists a reserve army of labour which acts as a barrier against wages increasing beyond the minimum that justifies payment of subsistence wages just to enable labourers perform work. Partly, this theory has been criticized for failing to contribute analytically to the difference between rent and profit, since it placed little emphasis on the law of diminishing returns. In addition, this theory advanced by Karl Marx viewed the price at which labour was supplied to be fixed in commodities, implying that the surplus of a commodity per employee when divided by the labour cost determines the share of profits in output.

There are two sectors in this presentation: capitalist and non-capitalist sector. Advancement of the capitalist sector absorbs more labourers from the disappearing non-capitalist sector owing to differences in productivity per person among the sectors. Over time, owing to capitalist sector accumulation, demand for labour rises above the rise in labour supply, subsequently resulting to scarcity of labour, increased wages and elimination of profits which and ultimately a capitalism crisis. Accumulation by capitalistic enterprises is due to competition among the capitalists. It was assumed that the capital used by capitalists depended on their own accumulated capital, thus there existed economies of large scale production.

This Marxian theory received criticism on the lines that the law of the increasing organic composition of capital cannot be used to derive the law of falling rate of profit. In this regard, there is no justification that the result of an increase in organic composition of capital, which leads to higher output per employee is a lower rate of profit when the price at which labour is supplied is unchanged in products. In addition, even when output per employee rises at a slower rate than capital per employee, the monetary value of surplus per employee must increase at a faster rate than output per employee. In this case, therefore, in spite of declining productivity owing to increases to fixed capital per unit of labour, the rate of profit might be on the rise. Thus, it is the organization of the working class that allows for increases in wages in commodities by forcing capitalists to surrender part of the surplus value (Kaldor, 1955-1956).

2.2.3 Marginal Productivity Theory

The neoclassical theory posits that income is earned in the process of production, with the productive factor's value reflecting its contribution to total product. Von Themmen in 1840 claimed to have discovered this theory, but Jean Baptiste Say in the 19th century already recognized the idea. However, the development of the theory was impeded by failure to account for the contributions of various inputs, since there can be no product when labour is not employed, and minimal output may arise without use of capital.

The theory is associated with the names of J.B Clark (1889), and P.H. Wicksteed (1894). Clark (1900) introduced the marginal products theory to solve this problem. Marginal product for labour was explained to mean additional output from using one more unit of labour in the mix of existing productive factors. The assumptions of this theory are: main objective of a firm is to maximize profit; perfect competition exists in product and factor markets; and perfect substitutability among units of factors of production and full employment of resources. At the optimum, therefore, the rate wage is analogous to marginal product of labour. It follows from the law of diminishing marginal productivity that there is a point beyond which further use of input leads to lesser output. Of specific emphasis, thus, is that the marginal cost rises when a firm sustains the increase in the amounts of factors of production - getting to a point where the marginal cost rises above the marginal revenue and subsequently decreasing marginal productivity. Conversely, a firm makes a decision to employ an additional unit of a factor of production whenever the marginal revenue is above the marginal cost incurred in the production process.

The theory has been criticized for unrealistic assumptions. It is claimed that a perfectly competitive economy may not exist in the real world. Second, it is difficult in practice to accurately measure marginal productivity, such that other factors are usually held constant in the determination of marginal productivity of a factor - which ideally is impossible in the real world. Notwithstanding, the mathematical elegance of this approach has always stood out as an advantage.

2.2.4 The Solo-Swan growth theory

The theory was proposed by Solow (1956) and Swan (1956) and has come to be referred to as the Solow-Swan Model. The assumptions of the theory are: constant returns to scale for the factors employed; labour and capital are factors of production and are exogenous - paid according to their marginal physical productivities; flexible prices and wages; full employment of labour and available stock of capital; neutral technical progress; constant saving ratio; and substitutability of labour and capital. The theory asserts that steady economic growth can be accomplished with efficient utilization

of labour, capital and technology. Output per capita in the long run will converge to its steady state independently of initial conditions based on assumptions mentioned. Sustained exogenous increase in primary factors (exogenous technological change and population growth) are the only potential sources of growth. Further, the growth rate in the long run is not affected by the savings or investment rates. When saving rate increases, it increases the steady state value of capital per worker but does not have a growth effect. In short, growth is exogenous since the behaviour of economic agents does not change the steady-state growth rate. According to this theory, technology augments labour productivity and increases the output capabilities of labour. The Solow-Swan Model (Swan, 1956; Solow, 1956) is anchored on the assumption that the rate of technical progress is an outcome of a scientific process – independent and separate from economic forces. To sum up, the Solow - Swan model asserts that economists should understand growth rate in the long-run to be exogenous - out of the economic system.

2.2.5 Endogenous growth theory

This theory suggests that sustained growth is endogenously generated at rates influenced by taste and technology, and tax policy. It was developed due to the weaknesses in the Solow-Swan model. Specifically, these models place emphasis on technological progress to be generated from the size of the stock of capital, size and quality of human capital, and the investment rate in the economy. The theory is based on assumptions that include: presence of a large number of firms and individuals; for all factors there is increasing returns to scale while constant returns to scale is faced for a single factor; and, advances in technology rely on new ideas with firms earning profits from ideas. For the preceding assumption, it is increasing returns to the scale of production which results to imperfect competition.

In this theory, technology affects capital, with the rate at which technology increases relying on the rate at which capital increases – in contrast to the Solow model.

2.3 Empirical Literature Review

Mahmood (2008) identified factors influencing productivity, including competition arising from open economic environment, new production technologies, reorganization in organizations, and changes in management methods owing to globalization. Increased work intensity, adoption of skills to fit new technology and reforms in labour market contribute to productivity.

In addition, low productivity in the sectors such as beverage and tobacco of SMEs is attributed to domination by larger multinationals and other enterprises (Mahmood,

2008). Some of the factors advanced for the disparity include variations of the structure in industry, capital intensity, skills and the emergence of new technology. This study finds no sound relation between employment growth and productivity in Australian SMEs over 1994-2000.

Jajri (2007) identified education and training, economic restructuring, capital structure, demand intensity as determinants of TFP. The study found technical change has a positive influence with the index growth at approximately 1.038. Capital per GDP rate was found to have a negative impact on TFP growth - suggesting technology is not properly absorbed and possibly substantial diminishing returns to capital. Education measured as the fraction of labour force having tertiary education had a positive influence on TFP growth, even though the coefficient was statistically insignificant. The study was conducted in Malaysia over the period 1971-2004.

Education

Despite the long standing debate about the relationship between education and productivity, many studies attribute higher labour productivity to higher levels of human capital (Su and Heshmati, 2011). In the human capital theory put forward by Becker (1964), workers who are more productive are usually a result of development in skills through education while the differences in wages would be seen in variations in output per employee – with better educated workers earning higher wages, all else equal (Rycx, Saks and Tojerow, 2015).

Empirical findings suggest that education influences output per employee positively and the influence is significant. Rycx, Saks and Tojerow (2015) estimate the growth in productivity at about 1.09 per cent due to a 10 percentage point increase in the proportion of high educated workers – substituted by a similar reduction in the proportion of middle-educated workers. However, this link may vary depending on the workers' age, sex and sectoral affiliation. This study also reveals that the credentials of young workers have a stronger influence when compared rather than on the costs of wages. A study by Su and Heshmati (2011) found the returns to education to be higher in China compared to other transition economies. Across countries, a strong positive correlation between average education levels and subjective evaluations of life is observed (Helliwell, Huang, Grover and Wang, 2014). However, when allowance is made for income of the respondent, health and social trust, the remaining positive link usually disappears, and sometimes turns negative. Benos and Karagiannis (2016), in a study in Greece, confirm the strong positive link between education and labour productivity through post-secondary education. They also find that primary and lower secondary education display a negative, and no association with productivity, respectively.

Annabi (2017), who simulate using the Overlapping Generations Model (OLG) find that productivity gains that can be sustained arise from higher education expenditure that are tax-financed. This is true when accounting for exogenous effects of human capital (Annabi, 2017). For Kenya, Kibet (2015) and Oduor and Khainga (2010) find a negative relation between education and labour productivity. Although the former attributes that to data problems, Oduor and Khainga (2010) attirbute that to poor quality of eduction and low rewards to education that lead to brain drain.

Capital intensity

Capital intensity, also called capital deepening, refers to the capital available to a worker. A capital intensive firm needs large amounts of finance in the production process (Lannelongue, Gonzalez-Benito and Quiroz, 2017). Business units that are highly capital intensive put emphasis on using investments, with concerns over costs and efficiency, and are thus able to increase their labour productivity (Sen and Farzin, 2000).

In assessing the relationship between labour productivity and capital intensity, use of TFP is characterized by one drawback - capital-labour ratios tend to differ a lot across sectors. In almost every country, the mining industry has an average level of labour productivity far higher than the average for the economy. On the same vein, the chemical sector within the manufacturing industry tends to have a higher than average labour productivity (Van Biesebroeck, 2015). This suggests that large output gains can be made by reallocating workers between sectors. Labour productivity can be increased from two sources: capital intensity and technical progress.

There are two ways capital intensity is affected by changes in population: Mechanical effect and change in equilibrium effect. The mechanical effect occurs when for any equilibrium capital - labour ratio, capital adjusts to labour changes over time - resulting to a short-run increase in the ratio of capital-labour as a response to ageing. On the other hand, shifts in demand between sectors with varied capital-labour ratios affect the equilibrium average ratio of capital - labour (Volek, 2013).

Bjuggre (2017) found increases in output per employee to result from a combination of higher capital intensity and TFP in India. The coefficient on capital intensity was 0.306 and statistically significant. The study found that TFP and capital-labour ratio account for 67 per cent, and 33 per cent of the increase. As a result, changes in labour adjustment costs can have an influence on the capital intensity choice, which influences labour productivity directly (Bjuggre, 2017). Malick (2013) find a positive and statistically significant coefficient of capital intensity in 34 OECD countries over 1990-2012. The results conform to Giannangeli and Gómez-Salvador (2008) although the coefficient is still 0.18 but over 1993-2003 in Belgium, France, Germany, Italy and Spain.

Macroeconomic stability

Macroeconomic stability is important in an economy's long-term improvement. A stable macroeconomic environment boosts investor confidence by helping to reduce the risks and uncertainty associated with macroeconomic instability. High inflation and unsustainable public finances may have adverse effects on aggregate economic performance through the effects on production costs of firms, real interest rates and availability of investible resources (Oduor and Khainga, 2010). Kibet (2015) found that a unit decrease in macroeconomic stability reduces labour productivity by 4.365 times. Oduor and Khainga (2010) found a negative but statistically insignificant coefficient and conclude that the macroeconomic environment could have been relatively stable during the study period.

Technology

In an open economy, empirical evidence suggests that international transmission of technology contributes to the growth in productivity of other countries (Apergis, Economidou and Filippidis, 2008). Research and development, market regulations, and the stock of human capital are some important factors that affect a nation's ability to gain from spillovers in technology.

Biesebroeck (2003) studied US automobile firms and found that while the association is positive, for new technolgy, growth in labour-saving productivity is higher compared to that of Hicks-neutral. Malikane and Chitambara (2018) find a feeble influence of technology on the growth in productivity of 45 countries in Africa over 1980-2012. Thus, there is limited absorptive capacity (relative backwardness of such technologies) as they require sufficiently developed human capital, which is not the case in Africa (Malikane and Chitambara, 2018).

Wages

The neoclassical approach asserts that higher labour productivity is reproduced entirely in higher wages (Nikulin, 2015). The level of wages is an important determinant of labour cost competitiveness in a country with a low proportion of the wage rate to gross value added per employee that is declining, inferred to mean that labour cost competitiveness is low. This has an effect of reducing ability to expand, and create durable and productive jobs (Omolo, 2010).

Nikulin (2015) found the changes in ratio of wages to be closely linked to that of productivity with the correlation coefficient exceeding positive 0.7, for Hungary, and Estonia Czech. Heshmati and Rashidghalam (2016) find the coefficient of wage elasticity to lie between 0.49 and 0.51. Biesebroeck (2011) in a study of Kenya, Tanzania and Zimbabwe found that male wages and productivity were not equal at a 10 per cent significance level. Female workers' salary premium is higher compared to their

male counterparts, and not as the benefit in terms of productivity (Biesebroeck, 2011). Given the characteristics of labour markets, firm-worker rates of matching and wage bargaining power are affected by human capital. Usually, employers offer wage offers that are between employees outside alternative, which is and the productivity. Wages are expected to be more elastic with experience and schooling than the productivity return.

Participation

When participation rate is low, it suggests that owing to skills or age the productive employees are engaged in production. Belorgey, Lecat and Maury (2004) assert that over time, with expansion in employment, the less productive workers will be involved. Thus, participation could be inversely associated with labour productivity. Belorgey, Lecat and Maury (2004) find an inverse relation between employment and productivity.

Government Expenditure

Government expenditure is necessary in providing a conducive environment for economic activities to take place. Such expenditure may be on health, education, or ICT. For example, increases in medical services spending raise the status of health and people's productivity (Nurudeen and Usman, 2010), further enhancing economic growth. Aside health, government expenditure education raises the productivity of existing capital stock (Irmen and Kuehnel, 2009). Additionally, the quality of labour can be improved through training while the quality of resources put into productive use can be boosted through agricultural sector investments (Besharat and Amihramadi, 2011). On previous studies, Narudeen and Usman (2010) estimate a positive and significant effect while Besharat and Amirahmadi (2011) found that an improvement in one percent resource's quality, yields 0.039 per cent rise in labour productivity.

Share of labour in agriculture

The productivity-employment nexus has been examined in in two opposing forces. As productivity increases, employment falls since less inputs of labour are needed for the same output level. However, the demand for labour will rise as demand for commodities increases owing to reduction in their prices due to higher productivity. (Mahmood, 2008). In this context, it has been argued that productivity growth leads to unemployment due to a reduced demand for labour (Rezai and Semmler, 2008). To sum up, growth in productivity may lead to unemployment in the short run but not in the long run (Gali, 1999).

Openness

Increased openness is characterized by benefits that include healthy competition, adoption of new technology, and demand for quality skills (Miller and Upadhyay,

1997). In addition, an open regime provides an incentive for innovation and provides opportunities for domestic firms and industries to gain substantial access to dearer intermediate imports, expansive markets, and modern technologies which are important in improving labour productivity (Oduor and Khainga, 2010). Oduor and Khainga (20100 find that openness affects labour productivity negatively in Kenya.

Governance

Governance is a multifaceted concept and means government's potential to make and enforce rules, and deliver services, whether either democratic or not (Fukuyama, 2013). Good government is defined as that which improves economic growth through incentives to increase productivity and shift activity to more economically productive activities (Helliwell, Huang, Grover and Wang, 2014). Good governance has been shown to have a positive correlation with output per worker. In addition, the quality of political institutions affects economic growth by providing the social stability, public services, and enforcing contractual obligations necessary for growth (Bloom, Canning and Sevilla, 2004; Aron, 2000).

Helliwell, Huang, Grover and Wang (2014) estimate that labour productivity of the economy may increase by 0.74 if quality of government is increased by one unit. Pontoriero (2017) with aid of simulations in Italy found that the effect of a 10 per cent increment in economic governance after 1994 led to an increment in labour productivity but, after few years, it decreased below the" business as usual" scenario (Pontoriero, 2017). Empirical evidence suggests that governance weakness influenced performance of the economy of Kenya over 1980s and mid-2000s. Heshmati and Rashidghalam (2016) assert that the manufacturing sector became uncompetitive owing to import substitution strategies and interference in the private sector by authorities over the same period. Still in Kenya, Kibet (2015) found that a unit increase in bad governance measured as indicator on political instability reduces total factor productivity by 69.68 per every unit increase. Thus, governance weakness including presence of corruption will have negative effects on labour productivity, which supports the view of "sand the wheels" (Myrdal, 1968; Meon and Sekkat, 2005) on quality of governance. Although there is another strand of argument that poor quality governance may improve labour productivity, no rigorous empirical evidence in support is available ((Meon and Sekkat, 2005).

Health

Good public health, reflected in longevity, is also conducive to increased labour productivity and economic growth. Bloom, Canning and Sevilla (2004) estimate that if life expectancy improves by one year, output rises by 4 per cent. In addition, this study argues that better outcomes in health might improve output through capital accumulation.

3. Methodology

3.1 Empirical Framework

This study follows the theoretical framework in Heshmati and Rashidghalam (2016) and Valadkhani (2003). Studies on labour producitivty begin with presenting the underlying production function with which inputs are converted to outputs. The production function for aggregate output used in this presentation is of the form:

$$Y = f(L, K, S) \qquad 3.1$$

Where, Y, is aggregate output (Real Gross Value added), L is labour, K is Capital while S is human capital. Equation 3.1 is referred to as the supply side approach (Valadkhani, 2003), following Maden and Savage (1998) and Romer (1989). It is argued that when the underlying production function depicts increasing returns to scale, the Cobb-Douglas production function yields biased parameter estimates. According to Valadkhani (2003), the assumpiton is adopted in many studies.

To find output per person, 3.1 is divided by Labour to obtain 3.2

$$Y/L = f(K/L, S/L) \qquad 3.2$$

The left-hand side of 3.2 is the output per worker which is our definition of labour productivity while the right hand side is its determinants. Output per unit of labour input may increase as a result of improved efficiency and quality of labour, and other factors such as technology, and institutions, and not solely labour (Heshmati and Rashidghalam, 2016).

In the Valadkhani (2003), the model of productivity is augmented by the real wage rate as an incentive, which in literature is expected to have a positive influence on productivity. Further, the labour force participants, both part-time and full-time, vary across time, making output per working person a biased measure of productivity (Valadkhani, 2003). In spite of this, labour is still used because it is readily available in data. Productivity improvements can also arise from ICT (Heshmati and Rashidghalam, 2016).

Given the influence of the factors mentioned above and others mentioned in the literature, such as macroeconomic stability, openness, and government expenditure, then 3.2 can be specified as 3.3

$$Y/L = f(K/L, S/L, W/P, T, ICT, H, PSt) \qquad 3.3$$

Where, *Y/L*, is output per person (labour productivity), *K/L* is capital per person, *S/L* is human capital per person, *W/P* is average real wages per person, *T* is Technology, *ICT* is Information Communication Technology, *PSt* is political stability.

To estimate 3.3, an estimable equation that incorportaes the factors reviewed in the literature is specified as:

$$Y/L = \beta_0 + \beta_1 (K/L) + \beta_1 (S/L) + \beta_2 (W/P) + \beta_3 (T) + \beta_4 (ICT) + \beta_5 (H) + \beta_6 (PSt) + \beta_7 (Openness) + \beta_8 (Macro) + \beta_9 (Gexp) + \beta_{10} (Agrla) + \varepsilon_t \quad 3.4$$

In 3.4, β_i, $i = 1,2,3, \ldots n$, where $n = 6$ are parameters to be estimated, *Macro* is the measure for macroeconomic stability, *Gexp* is government expenditure, *Agrla* is the share of Labour in agriculture, and ε_t is the stochastic disturbance term that is assumed normally distributed.

3.2 Data type, Source and Definition and Measurement of Variables

Secondary time series data spanning the period 2000-2016 was used in this study. This period saw many reforms that might have had influence on labour productivity in Kenya including the end of 24-year rule in 2002, free primary education in 2003, internal shock of the 2007 post-election violence, shift of trade partners form the West to the East since about 2008, and increasing adoption of ICT through 2016. The data type, definition, measurement, expected sign and sources are shown in Table 3.1. There is no time series data on labour participation hence World Bank estimates are used. The ILO estimates on total employment per sector of the economy was preferred for it exhaustively provided employment numbers (both formal and informal) in all sectors of the economy which could not be found in the economic surveys of KNBS. Nevertheless, when the numbers from the KNBS were compared to the former, the differences between the two were very small and insignificant

Table 3.1: Data type, source and definition and measurement of variables

Variable	Measurement	Units	Expected sign	Data Source
Capital	Gross fixed capital formation	Ksh		KNBS
Labour	Persons employed	Units		ILO
Labour Productivity	Log of the ratio of Gross Value Added at the economy (or sector) to persons employed in the economy (or sector)	Ksh	Dependent Variable	KNBS and World Bank
Education	Mean years of schooling derived as the average number of years of education received by people ages 25 and above excluding years spent repeating individual grades	Units	+	UNDP (Human development Reports)
Capital Intensity	Log of the ratio of gross value added at the economy to the total number of persons employed in the economy-	Ksh	+	Own computation using KNBS and ILO
Macroeconomic stability	Rate of Annual Inflation	Per cent	-	Central Bank of Kenya website
Technology	Number of new patent applications by residents each year	Units	+	World Intellectual Property Organization (Patent Cooperation Treaty)
Participation	Labour force participation rate which is measured as the total number of persons currently employed or in search of a job.	Per cent	-	World Bank
Government Expenditure	Log of Total government outlays by the National Government on development and consumption	Ksh	+	World Bank
Share of Agriculture in GDP	Total value of output in in Agriculture divided by total value of output in the economy	Per cent	-	Own Computation
Openness	Sum of Exports and Imports divided by GDP	Per cent	+	World Bank
Wages	Average earnings per Employee per year	Ksh	+	KNBS

Source: Own Construction

4. Empirical Findings

4.1 Descriptive Statistics

The sample consisted 17 observations over 2000-2016. Descriptive statistics are presented in table 4.1. In general, labour shows the highest dispersion while capital input in million Kenyan shillings has the lowest dispersion.

Table 4.1: Descriptive statistics

Variable	Mean	Standard Deviation	Minimum	Maximum
Gross value added	2657,645	591751.4	1891689	3808823
Labour	1.32E+07	2010012	1.07E+07	1.70E+07
Capital	412506.5	263128.3	160241	883604
Labour Productivity	2.298	.031	2.25	2.35
Education	5.919	.333	5.3	6.3
Capital Intensity	4.419	.206	4.15	4.73
Macroeconomic Stability	8.551	3.480	4.77	14.28
Technology	78.53	48.25	22	144
Wages	5.548	.172	5.24	5.82
Participation Rate	66.895	1.771	65.22	71.65
Government Expenditure	8.193	1.828	.88	8.82
Share of labour in Agriculture	0.659	0.0169	0.63	0.68
Openness	54.075	6.043	37.93	64.48

Source: Own computation

The summary statistics results presented in Table 4.1 show that in terms of dispersion, technology, openness followed by macroeconomic stability show the highest spread while labour productivity and share of labour in agriculture have the lowest spread. The average output per person over the study period in logarithms was 2.3 while the average wages per employee in logarithm was 5.5. In terms of education, the average years of schooling over the period is 5.9 which corresponds to primary level education while the participation rate in the economy stands at 67 per cent. Agriculture dominates employment with its share of labour in total employment standing at about 66 per cent. The average government expenditure over the study period is Ksh 431,327 million with its standard deviation suggesting it could have risen moderately over the study period.

The variables were plotted against time to understand how they behaved. The line graphs are presented in Figure A1 through Figure A18 in the appendix. The figures show that most variables were either trended upward or downward except the measure of macroeconomic stability and to an extent government expenditure

that remained relatively non- trended over the study period. The log of labour had an uninterrupted trend while that of log of gross value added had downward-like movements in the early 2000 and prior to 2010. The downward-like movements could be attributed in part to internal shocks associated with the 2007 elections, respectively. The log of capital, was somewhat erratic prior to 2012, but rose in general over the study period indicating increasing adoption of capital in the economy.

Correlation was done to reveal the association between the variables. The correlation matrix is presented in Table 4.2a and 4.2b. The correlation results show that wages, education, capital intensity, technology, government expenditure, and health have positive association with labour productivity, with the correlation coefficients statistically significant at 10 per cent. The positive association with technology suggests that an enabling environment for innovation and invention is important in increasing labour productivity. Indeed, the results suggest that an increase in government expenditure to support innovation and improve the quality of education will improve the skills in the labour market and increase their labour market returns and be associated with labour productivity.

Table 4.2a: Correlation matrix

	Labour Product-ivity	Wages	Education	Capital Intensity	Macro stability	Openness	Government Expenditure
Labour Productivity	1						
Wages	0.973*	1.000					
Education	0.972*	0.982*	1.000				
Capital Intensity	0.918*	0.908*	0.869*	1.000			
Macro stability	-0.427	-0.341	-0.278	-0.212	1.000		
Openness	-0.526	-0.509	-0.265	-0.519	0.411	1.000	
Government Expenditure	0.934*	0.948*	0.900*	0.932*	-0.242	-0.639	1.000
Technology	0.907*	0.922*	0.887*	0.927*	-0.266	-0.476	0.936*
Political stability	0.618	0.647	0.439	0.624	-0.594	-0.725*	0.714*
Health	0.974*	0.974*	0.985*	0.922*	-0.281	-0.442	0.938*
Participation	-0.674	-0.730*	-0.779*	-0.465	-0.019	0.025	0.108

** Shows a coefficient is statistically significant at 1 per cent level of significance.*

Source: Own computation

Wages has a positive association with education, capital intensity, technology, government expenditure, health but a negative association with participation rate – and the coefficients are statistically significant. This suggests that a more educated person could be seen to have more skills to be paid higher wages. Healthy persons stand a higher likelihood of being employed and therefore earning wages compared to the less healthy. The results further suggest that if the labour participation rate increases, then the level of education falls possibly indicating that in Kenya people further their studies as a response to unemployment. As the quality of education increases health outcomes improve. Capital per person increases with government expenditure and better health. Further, if the economy becomes more politically unstable, the benefits associated with liberation are eroded possibly due to lack of confidence by traders, both local and foreign. More government expenditure will be used in the period the economy becomes more politically unstable, pointing to the costs of providing security and enforcement of law and order and possible reconstruction after events of destruction of property or looting, and hospital bills.

Table 4.2b shows the correlation between the labour shares and shares of output in agriculture, manufacturing, and services industries. In the correlation with sectoral labour productivity, the correlation coefficients on the shares of labour in manufacturing, agriculture and services are statistically significant. The results suggest that to increase labour productivity, labour should shift from agriculture to manufacturing and services – lending support to the structural transformation thesis in the dual economy models proposed by Lewis (1954). Specifically, the correlation between share of labour in agriculture and share of labour in manufacturing is 0.90, suggesting that about 90 per cent of labour could shift from agriculture to manufacturing and grow manufacturing output as a basis for industrialization.

Table 4.2b: Correlation matrix

	Labour productivity	Share of labour in agriculture	Share of labour in manufacturing	Share of labour in services	Agricultural share in GDP	Services share in GDP	Manufacturing share in GDP
Labour productivity	1.000						
Share of labour in agriculture	-0.968*	1.000					
Share of labour in manufacturing	0.892*	-0.904*	1.000				
Share of labour in services	0.893*	-0.932*	0.838*	1.000			
Agricultural share in GDP	0.391	-0.514	0.390	0.613	1.000		

Services share in GDP	-0.336	0.462	-0.378	-0.558	-0.942*	1.000	
Manufacturing share in GDP	0.579	-0.616	0.624	0.485	0.204	-0.351	1.000
Technology	0.907*	0.922*	0.887*	0.927*	-0.266	-0.476	0.936*
Political stability	0.618	0.647	0.439	0.624	-0.594	-0.725*	0.714*
Health	0.974*	0.974*	0.985*	0.922*	-0.281	-0.442	0.938*
Participation	-0.674	-0.730*	-0.779*	-0.465	-0.019	0.025	0.108

** Shows a coefficient is statistically significant at 1 per cent level of significance*

Source: Own computation

The concept of transformation, that is, shifts in labour shares between sectors, is key in improving labour productivity. Such transformation is perceived to be positive as the manufacturing sector embeds larger benefits than more traditional sectors (Velde, 2017). The benefits of moving labour from agriculture to manufacturing include increasing returns to scale, larger income elasticity of demand, employment absorption, and increases in productivity and spillovers (Khanna, Papadavid, Tyson and Velde, 2016). Traditionally, manufacturing is responsible for innovation diffusion and also changes in productivity, though in Africa it performs poorly and has lost its competitiveness. This suggests that there has been ongoing shift in labour from agriculture into the manufacturing output in Kenya consistent with the development arguments that encourage industrial transformation. Peneder (2003) argues that productivity can increase from a combined effect of an increase in both labour productivity and share of employment in firms. The effect on labour productivity would however turn negative if those firms whose labour productivity is increasing faster do not sustain their shares in total employment (Peneder, 2002).

4.2 Findings for Stationarity Analysis

The next step was to examine the underlying properties of the data. This study employed time series data, for 2000-2016 in Kenya. With such kind of data, it was deemed fit to determine the properties of the series to ensure they are stationary and therefore avoid estimation bias (Yule, 1926; Granger and Newbold, 1974; Banerjee et al., 1993). The Philips Perron unit root test was used following the argument put forward by Pierre (1989) and Sjo (2008) that in the presence of unusual circumstances the conventional ADF unit root test would be invalid, for example in the presence of an explosive unit root (Suresh et al., 1999). Also, the PP unit root test is reported to be particularly robust to any heteroscedasticity in the error term. Moreover, the user does not need to specify the number of lags (Rothe and Sibbertsen, 2005) for this test. The results for Philips Perron unit root test are

presented in Table 4.3. The results show that most variables are stationary at first difference except government expenditure and capital which are stationary at the second difference.

Table 4.3: Unit root test results

Variable	Remark	Test Statistic	Critical Value at Levels of Significance				Inference
			1%	5%	10%	Mackinnon P-Value	
Labour Productivity	Level (with trend)	-2.50	-4.38	-3.6	-3.24	0.32	Nonstationary
	Fist difference	-3.696	-4.38	-3.6	-3.24	0.02	Stationary
Wages	level (no trend)	-1.21	-3.75	-3.0	-2.63	0.67	Nonstationary
	First difference	-3.05	-3.75	-3.0	-2.63	0.03	Stationary
Education	level	-4.13	-3.75	-3.0	-2.63	0.00	stationary
	level (with trend)	-0.14	-4.38	-3.6	-3.24	0.99	Nonstationary
	First difference	-8.42	-4.38	-3.6	-3.24	0.00	Stationary
Capital Intensity	level	-0.41	-3.75	-3.00	-2.63	0.91	Nonstationary
	First difference	-3.12	-3.75	-3.00	-2.63	0.03	Stationary
Share of Labour in Agriculture	Level	0.41	-3.75	-3.00	-2.63	0.98	Nonstationary
	First difference	-6.01	-3.75	-3.00	-2.63	0.00	Stationary
Macro-economic Stability	Level	-4.06	-3.75	-3.00	-2.63	0.00	Stationary
Openness	Level	-0.40	-3.75	-3.00	-2.63	0.91	Nonstationary
	First difference	-3.41	-3.75	-3.00	-2.63	0.01	Stationary
Government Expenditure	Level	-1.04	-3.75	-3.00	-2.63	0.74	Nonstationary
	First difference	20.43	-3.75	-3.00	-2.63	1.00	Nonstationary
	second difference	-14.96	-3.75	-3.00	-2.63	0.00	Stationary
Gross Value Added	Level	-1.07	-4.38	-3.6	-3.24	0.93	Nonstationary
	Fist Difference	-3.69	-4.38	-3.6	-3.24	0.03	Stationary
Labour	Level	-2.55	-4.38	-3.6	-3.24	0.3	Nonstationary
	Fist Difference	-2.98	-4.38	-3.6	-3.24	0.14	Stationary
	Second Difference	-5.19	-4.38	-3.6	-3.24	0	Nonstationary
Capital	Level	-2.47	-4.38	-3.6	-3.24	0.34	Stationary
	Fist Difference	-2.89	-4.38	-3.6	-3.24	0.16	Nonstationary
	Second Difference	-6.25	-4.38	-3.6	-3.24	0	Stationary

Source: Own computation

The variables for macroeconomic stability and education (level) are stationary at level. The next test was to determine the order of cointegration of the series under investigation. In this respect, the Johansen and Juselius cointegration test (Johansen and Juselius, 1990) was adopted. The results of the test indicated that the null hypothesis was not rejected using the trace statistic and maximum eigenvalue. The conclusion was that there was no evidence of long term relationships among the variables. These results were not presented as they were insignificant.

4.3 Distribution and other Diagnostic Test Results

Before accepting the results from the regression, diagnostic and distribution tests were conducted. The test done was heteroscedasticity, serial correlation and normality. Heteroscedasticity was tested using the Breusch-Pagan test. The results showed that the null hypothesis of constant variance could not be rejected. The conclusion was that the variance was not exposed to heteroscedasticity problems. The Durbin Watson statistic was used to test for the presence of serial correlation. Usually Durbin Watson test shows that serial correlation could be a problem when the test statistic provides a value approaching two, in absolute terms. The null hypothesis that error terms were not autocorrelated was rejected. To correct for this problem, the Newey-West (Newey & West, 1987) standard errors were used. Bartlett's periodogram-based test for white noise was used to test whether the process/distribution came from a sample that was normally distributed. The results are presented in Table 4.5 and plotted in Figure A19 in the appendix. The null hypothesis that the process is not different from white noise was not rejected. There was evidence of strong correlation between the independent variables which led to the dropping some of the variables including political stability and health.

4.4 Estimation Results

4.4.1 Total factor productivity

After ascertaining the nature of integration of the variables, the next step was to run a regression on the Cobb-Douglas Production function with the aid of equations 6.1 through 6.4 in the appendix. The regression was restricted for constant returns to scale (CRS) to allow compute the factor shares for labour and capital. The results for the restricted linear regression are presented in Table A1 in the appendix. The results of the factor shares are presented in Table 4.4.

Table 4.4: Elasticities of capital and labour

	Alpha	Beta
Coefficient	0.14***	0.86***

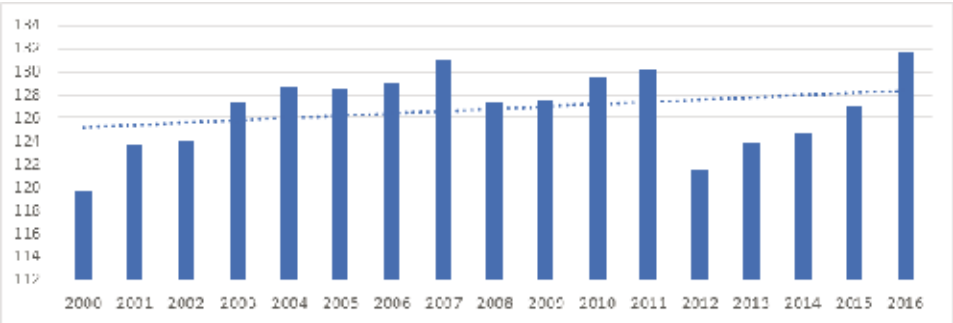
*** - *coefficient is statistically significant at 1 per cent level of significance.*
Source: Authors' Computation based on KNBS and ILO data for 2000-2016.

The alpha coefficient was interpreted as the rise in output due to a unit rise in the capital input while the beta coefficient was the increase in gross value added due to a unit rise in the labour input. The results suggest that the elasticity of labour is higher compared to that of capital over the study period. These values are determined by existing technology and thus constant. We conclude that the economy uses more labour to produce output than it uses capital. On the same vein, when total factor productivity is included, the elasticity of labour falls to 0.62 compared to that of capital that rises to 0.38 (total factor productivity included).

The cost of labour (wages) is high in Kenya compared to countries such as Ethiopia, Rwanda, Malawi, and Egypt (Ramachandran et al., 2017). A high share of labour in production means a higher payment for labour to produce output. This leads to a higher cost of production in Kenya relative to other African countries. This poses a threat of industries moving from Kenya to those countries in the region with comparative advantage in production, hurting the prospects of the Vision 2030 which focuses on industry to drive economic growth. Further, adjusting the minimum wage to cushion the lowly-paid employees from inflation will continue to be a problem given that the minimum wage is expected to rise to Ksh 15,372 in 2018. This is based on recommendations by the Central Organization of Trade Union, and Federation of Kenyan Employers.

Total factor productivity was computed using equation 3.7. The approach and further information is provided in Table A2 in the appendix. The computed values for total factor productivity (TFP) are presented in Figure 4.1.

Figure 4.1: Multifactor productivity for the Kenya economy, 2000-2016



Source: Authors' computation

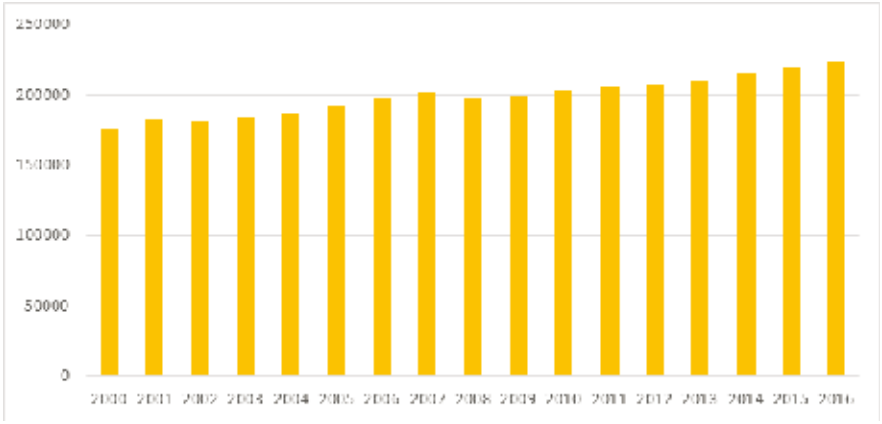
The figure shows that TFP has been rising slowly during the study period, with the highest decline observed in 2012. Thereafter, recovery is observed, attaining a peak at the end of the study period – and above the highest observed values in 2007.

The values obtained in this approach are larger than those observed when stationarity analysis is not undertaken (see, figure A20 and A21 in the appendix). These results indicate that TFP is less than unity and has been constant or rising slowly over the study period. TFP captures the effects of changes in technology, institutions, and other productivity shocks, but it gives little insights as to what takes place inside the black box of technology. It is often assumed that increases in productivity, as captured by TFP, allow for increases in real wages (Kohli, 2015).

4.4.2 Labour productivity

Figure 4.2 presents computed labour productivity over the study period using the formula in Table 3.1.

Figure 4.2: Labour productivity (Ksh '000)



Source: Authors' computation

Kenya's labour productivity performance was somewhat uneven over the study period but overall increasing over the study period. In 2016, measured labour productivity for the economy was 27 per cent higher than it was in 2000, an average annual growth rate of 1.5 per cent.

4.4.3 Sectoral labour productivity

Assessing labour productivity performance at the sector level provides further insights into the drivers of aggregate productivity performance. This assessment

also provides an indication on the extent to which Kenya has benefited from broader economic change, such as the rapid expansion in telecommunication and financial services, increased investment in education and ease of doing business reforms. The approach adopted follows Khanna et al. (2016) where the economy labour productivity is used as the baseline. In this approach, the sector output was first divided by the number of persons working in the sector following formula in Tabel 3.1. In the second stage, the value found in the first stage is divided by the value of productivity obtained for the economy. The results are presented in Table 4.5.

It is apparent that the services industry has a fairly higher output per person followed closely by manufacturing industry. In this segment, the economy labour productivity is used as the baseline. In the services industry, the real estate followed by fairly well with their labour productivity about 97 and 13 times the economy average. In the manufacturing industry, the utilities sector dominates with labour productivity about 11 times the economy average as of 2016. The agriculture industry has the lowest Labour productivity with the agriculture and mining sectors being 1.8 times and 0.4 times compared to the economy average, respectively. This is despite the fact that agriculture is the largest contributor to GDP

4.4.4 Factors affecting labour productivity

The regression results for factors affecting labour productivity are shown in Table 4.6. The results suggest that all variables included in the model are important in explaining labour productivity over the study period. The results further point out that about 99.7 per cent of the variations in labour productivity are jointly explained by the independent variables included. To note, however, no coefficient on a variable is statistically significant at 1 per cent level of significance. All the coefficients exert positive influence on labour productivity except the measure for macroeconomic stability, openness and participation rate. The negative sign on the coefficient of openness was not expected.

Table 4.5: Sectoral labour productivity

	Agriculture Industry		Manufacturing Industry			Services Industry									
	Agriculture	**Mining**	**Manufacturing**	**Utilities**	**Construction**	**Wholesale**	**Transport**	**Accommodation**	**Financial**	**Real estate**	**Public administration**	**Education**	**Human health**	**Other service**	**Economy**
2000	0.45	0.83	2.95	10.54	1.49	0.72	3.13	15.24	13.00	101.24	2.35	2.41	2.51	4.11	1.00
2001	0.47	0.85	2.90	10.24	1.43	0.73	3.29	14.22	10.97	87.88	2.24	2.31	2.40	4.05	1.00
2002	0.45	0.87	2.90	11.96	1.42	0.70	3.47	15.02	10.44	91.37	2.18	2.29	2.39	4.20	1.00
2003	0.45	0.86	2.96	13.45	1.36	0.69	3.43	11.81	10.24	81.97	2.11	2.42	2.36	4.04	1.00
2004	0.44	0.82	2.95	13.08	1.32	0.72	3.46	14.65	9.81	74.77	2.03	2.35	2.32	4.00	1.00
2005	0.45	0.80	2.88	12.64	1.32	0.71	3.53	16.12	9.86	68.21	1.92	2.25	2.24	3.86	1.00
2006	0.44	0.87	3.24	11.54	1.40	0.50	2.88	23.11	12.55	119.21	1.88	1.93	1.77	1.40	1.00
2007	0.43	0.96	3.15	11.83	1.38	0.50	2.90	23.56	12.11	122.59	1.85	1.92	1.75	1.32	1.00
2008	0.41	0.96	3.21	10.77	1.37	0.51	2.96	15.30	12.54	128.57	1.95	2.08	1.79	1.33	1.00
2009	0.39	1.04	3.08	11.11	1.53	0.52	3.10	19.93	12.61	125.27	2.01	2.14	1.82	1.28	1.00
2010	0.41	1.29	3.15	11.16	1.60	0.53	3.16	18.01	13.82	128.13	1.92	2.22	1.80	1.25	1.00
2011	0.40	1.45	3.14	11.26	1.55	0.54	3.32	17.21	13.78	122.06	1.92	2.28	1.66	1.17	1.00
2012	0.40	1.65	3.08	11.56	1.62	0.55	3.20	16.55	13.70	117.99	1.86	2.40	1.51	1.16	1.00
2013	0.40	1.49	3.12	11.44	1.59	0.56	3.12	13.80	13.77	113.12	1.77	2.35	1.49	1.11	1.00
2014	0.40	1.65	3.06	11.28	1.62	0.56	3.16	10.68	13.87	109.67	1.80	2.39	1.51	1.07	1.00
2015	0.40	1.73	2.97	11.36	1.69	0.55	3.14	9.31	13.91	101.73	1.73	2.30	1.46	1.02	1.00
2016	0.40	1.76	2.89	11.13	1.70	0.54	3.18	9.90	13.78	97.56	1.75	2.29	1.43	0.99	1.00

Table 4.6: Regression results, factors determining labour productivity in Kenya

First difference of the log of labour productivity	Coefficient	Newey-West standard errors	t-value	P-value	95% Confidence interval	
First difference of education	0.1	0.002	58.510	0.011	0.078	0.122
First difference of log of capital intensity	0.041	0.001	32.14	0.02	0.025	0.057
Macroeconomic stability	-0.001	0.000	-6.91	0.091	-0.002	0.001
First difference of technology	0.002	0.000	19.57	0.032	0.001	0.003
First difference log of wages	0.494	0.039	12.81	0.05	0.004	0.984
First difference of participation	-0.034	0.002	-22.89	0.028	-0.053	-0.015
Second difference of the log of government expenditure	0.241	0.003	73.15	0.009	0.199	0.282
First difference of the share of agricultural labour	5.502	0.272	20.22	0.031	2.044	8.961
First difference of openness	-0.006	0.000	-19.9	0.032	-0.010	-0.002
Constant	-0.019	0.002	-8.89	0.071	-0.047	0.008
Prob > F	0.038					
R-squared	0.999					
Adj R-squared	0.99					
Breusch-Pagan / Cook-Weisberg test for heteroscedasticity chi2(1)				0.44		
Prob > chi^2				0.508		
Durbin-Watson d-statistic (10, 11)				2.315		
Bartlet (B) statistic Prob>B				0.52 0.95		

A one year increase in the years of schooling increases labour productivity by 10 per cent. This finding is consistent with previous studies, including Rycx, Saks and Tojerow (2015), Su and Heshmati (2011), Jajri (2007) - but the coefficient was not statistically significant in this case - and Becker (1964). This implies that a better workforce reduces the learning curve in acquiring new technology (Jajri, 2007). Although Helliwell et al. (2014) found the same result in a survey of 157 countries, they also established that when allowance is made for income of the respondent, health and social trust, the remaining positive link usually disappears, and sometimes turns negative. The finding on education is, however, inconsistent to findings of Kibet (2015) and Oduor and Khainga (2010), both studies done in Kenya. This may be attributed to several factors. First, the study period and the variable measure for education are different. This can be explained by difficulty in accessing data according to Kibet (2015). Further, Kibet (2015) uses the years of schooling for the persons above 25 years. In addition, it is claimed that in third world nations, the interaction of human capital and openness yield a positive effect (Miller and Upadhyay, 1997).

In the study by Oduor and Khainga (2010), the findings are attributed to poor quality of education, falling marginal productivity of workers, inefficiency of education (including low teacher - pupil ratio and low book - pupil ratio) and brain drain. The current study diverts from this study in two aspects: first, the study period is 2000-2016, and the issue is analyzed over the period 1982-2006. It is apparent there have been sustained efforts to improve educational attainment through, for instance, Free Primary Education (FPE) of 2003, government support for non-formal education schools with about 143 centres receiving grants in 2005 (KNBS, 2016), increasing allocation to the education sector and especially technical and teacher education in 2015, and recent Free Day Secondary Education. These efforts are crucial to increasing labour productivity in Kenya. Secondly, in this study, government education expenditure is used as a measure for education compared to mean years of schooling for the current study. It might turn out that government expenditure may be trended compared to the later. Despite this, data problems may also contribute to the disparities and the estimation procedures. This paper also reiterates the words of Oduor and Khainga (2010) that there should be concerted policy initiatives to reduce brain drain, for instance by improving salaries and working conditions of public servants (Oduor and Khainga, 2010). In developing nations, for instance, a majority of the skilled labour is employed by the public sector, which distorts estimates of returns to education as they are influenced not by market forces but by government regulations (Benos and Karagiannis, 2016).

Moreover, it is believed that after openness passes through some threshold, education contributes to labour productivity, with Miller (1997) estimating the threshold between 11 to 50 per cent. Human capital may therefore be under-utilized

if investment in education is not matched with liberalization of the external sector. In this study, descriptive statistics show that the variable lies between 37 per cent and 64 per cent.

A one per cent increase in capital per worker increases labour productivity by about four per cent, all else equal. This finding is consistent with that of Bjuggren (2017) in India, and Van Biesebroeck (2015). It is also consistent with Malick (2013) in a study of 34 OECD countries, and Giannangeli and Gomez-Salvador (2008) in a study of Belgium, France, Germany, Italy, and Spain estimating the coefficient at 0.18. In Kenya, over 1982-2006, Oduor and Khainga estimate that capital growth accounted for about 17 per cent of GDP growth. This means that government is in the right direction in focusing enough attention to more of capital per worker.

The results show that macroeconomic stability measured using the rate of inflation exerts a negative effect on labour productivity. An increase in inflation is considered an increase in instability. This confirms that in Kenya, macroeconomic stability has important influence on labour productivity, and thus should be kept on check if the economy must embrace efficient use of labour resource, as a factor input. This is consistent with Akinlo (2005) who found this true in 34 Sub-Saharan countries, and Christopoulos and Tsionas (2005) in 13 out of 15 European countries between 1961–1999. Further scrutiny of the coefficient, however, shows that it is small in magnitude; that is, a unit increase in inflation reduces labour productivity by about 0.05 per cent, all else equal. At the same time, Oduor and Khainga (2010) found the coefficient of inflation on TFP to be negative but statistically insignificant and conclude that the macroeconomic environment in Kenya has been relatively stable over the sample period, such that an increase in instability has not affected TFP growth in Kenya. Inflation reduces the incentive to work (Kumar, Weber and Perry, 2009), distorts the information in price signals, and increases the rental price of capital (Christopoulos and Tsionas, 2005).

A unit increase in the technology variable measured by number of new patents per year increases labour productivity by 0.2 per cent. Although the coefficient is small, this finding differs from that in Oduor and Khainga (2010), who established that the coefficient was statistically insignificant but consistent with that of Kibet (2015) for a study in Kenya, Jalles (2010) for 73 countries between 1980 and 2005 including Germany, Greece, Japan and Belgium, and Crossby (2000) in Australia. There is evidence therefore that the increasing pace in the use of advanced technologies more extensively induces higher productivity in the economy. In this context, the average value for Kenya during that period was 50 patent applications with a minimum of 1 patent applications in 1966 and a maximum of 144 patent applications in 2016. Increasing patent applications by residents reflects protection of ideas on the markets for new ideas, and increases productivity. As a matter of

caution, patents affect innovation and diffusion processes depending on features of the patent regime (Jalles, 2010).

The findings on the positive and significant effect of wages on productivity are consistent with those of Heshmati and Rashidghalam (2016) in Kenya, Nikulin (2015) and Biesebroeck (2011). This implies that labour productivity in Kenya would increase by 0.5 per cent if wages are increased by 1 per cent. This finding is consitent with exisitng literature; for example, the neoclassical theory that asserts that higher labour productivity is reproduced entirely in higher wages. Caution should be taken, however, on concluding about the wage-labour productivity nexus, as this is an issue still sorrounded with controversy. In this context, Millea (2002) argues that firms reward higher productivity by paying higher wages or pay high wages to stimulate productivity.

The coefficient on participation rate is negative and statistically significant while that on government expenditure is positive and statistically significant, consistent with Besharat and Amirahmadi (2011), Nurudeen and Usman (2010) and (Irmen and Kuehnel, 2009). This suggests that an increase in the persons in wage employment would bring the unproductive types and will reduce labour productivity. The share of labour in agriculture has a positive and statistically significant coefficient. The findings regarding the share of labour in agriculture suggests that concerted government expenditure on the quality of agricultural resources and social safety net programmes are important in building the necessary capabilities that can contribute positively to output per person employed.

The coefficient on openness is negative and statistically significant and consistent with the findings of Oduor and Khainga (2010). This suggests that even though government policies have been pushing for free trade and liberalization, too much of such liberation will affect labour productivity negatively, since local investors cannot compete effectively with cheap imports, cheap foreign labour and poor value addition in local industries. The relationship between openness and labour productivity depends on a number of factors, including the level of study, situation of a country, sample, how economic openness is captured, data and period of study (Cibulskene and Maciulyte-Sniukiene, 2014). Thus, case studies need to be conducted before concluding that openness determines labour productivity. When the share of trade as a percent of GDP is used, it shows that countries with more natural barriers are characterized by less productivity rewards relative to their counterparts (Girma, Henry and Milner, 2003). Higher natural barriers in Africa are thus more influential in reducing growth compared to other places (Foroutan and Pritchett, 1993).

5. Summary, Conclusions and Policy Implications

5.1 Summary

Understanding the efficiency with which labour is used in production, is important in the design of long term economic growth and development. The government puts emphasis on the same through development of Kenya Vision 2030 and focus to increase productivity by formation of the National Productivity and competitiveness center. This study estimates economy labour productivity as well as for the sector level, and determines the factors that affect it at the economy level. The study period considered was 2000-2016, based on time series secondary data obtained from the KNBS, and international sources such as ILO and World Bank. Like in other previous research, the approach adopted was to study labour productivity as the output per worker. The value added was used as the measure of the output while number of persons in employment was chosen as the input for labour. For ease of analysis, the sectors were aggregated into three industries: Agriculture, Manufacturing, and Services.

To estimate the total factor productivity (TFP) for the economy the study used a linear regression of the Cobb-Douglas production function with constant returns to scale (CRS) restriction. The criteria for computing the estimate for total factor productivity was to use the value provided for the constant as documented in the methodology. To determine labour productivity of the sectors, the ratio of gross value added to employment in the sector was computed. Finally, an Ordinary least square regression was run to determine the factors that determine labour productivity.

After evaluating time series properties of the data, the study established that in the process of converting inputs into output, approximately 86 per cent of labour compared to 14 per cent of capital input is used. In the second regression when total factor productivity is included, the elasticity of labour is 0.62 while that of capital is 0.38. The regression providing the share for labour and capital was also used to estimate the value of the TFP. The TFP computed riose about 10 per cent over the study period with a peak reached in 2016. Turning to labour productivity for the economy, the estimate rose close to the value observed for TFP about 27 per cent over the study period. The reason for the closeness is that the two variables are highly correlated as they are all measures of productivity with a difference being TFP is not a partial measure of productivity. The increase in the period could be closely associated with effects of the Economic Recovery Strategy, implementation of the Free Primary Education and the effects of better managed MTP I and MTP II. In addition, there has been increasing use of ICT in the economy with the banking and financial sector, in general adopting it. The government has also shown progress in

using it with the uptake of several digital activities like E-government system. The financial and services sector could be a key beneficiary in this aspect as it continued to embrace the technology through the study period evidenced by reduction in long queens in banking halls that was common at the first part of the study period. And although productivity is on an upward scale, it is important to note that concerted efforts are necessary especially that Kenya's productivity is far lower than other countries for example Singapore.

At the sector level, services industry seems to perform well compared to manufacturing and agriculture. The contribution of real estate and finance and Insurance activities is immense. The financial sector benefitted from the advent of ICT that offered alternatives to labour intensity such as internet banking, MPESA, and mobile banking platforms. In contrast, the agricultural sector, contributing more than a quarter to GDP and accounting for more than 60 percent of total employment, has the lowest labour productivity. It is essential to note that this sector suffers from perennial underemployment, seasonal unemployment, effects of climate change including drought and fluctuations in prices of output, high input costs, low mechanization, and changing land use to favor real estate. Given characteristics of a developing country, this sector cannot be neglected in driving the economy for the coming future.

Among the important factors that affect labour productivity in Kenya include education, earnings, capital per worker, technology, government expenditure and macroeconomic stability. The results suggested that a one-year increase in education could increase labour productivity by 10 per cent.

5.2 Conclusions

Labour productivity studies provide useful insights on the strategies that can lead to concerted long-term development, and creation of decent employment that increase the welfare and standard of living of society. Although the government policy direction has put emphasis on labour productivity since independence, there are no official estimates of labour productivity for the economy. First, this study finds that 86 per cent of labour input and 14 per cent of capital input are used in the production process leading to the conclusion that the economy is labour intensive and puts prospects of industrialization by 2030 in sharp focus. This study showed that labour productivity rose by approximately 27 per cent while TFP rose an approximated 10 per cent over the study period. In addition, the years which show decline in both measure of productivity, are years around national elections or droughts suggesting that internal shocks and uncertainties may be influential for the trend of labour productivity.

However, given the expectations of the vision 2030 and the youth bulge, it would be beneficial to improve labour productivity by influencing some of the factors that this study found important. In this study, services seem to have more productivity with the agriculture having the lowest. Boosting these sectors could lead to spillover effects on the entire economy that can indeed provide momentum for long term economic development as well as creating decent employment. Agriculture cannot be neglected given its contribution to GDP, employment, foreign exchange and the forward linkages it provides other sectors such as manufacturing and services.

Technology, wages, macroeconomic stability, capital intensity participation rate and education are important determinants of labour productivity in Kenya. Government policy direction that targets increasing labour productivity should target an improvement in these variables. Alongside this, education is found to have a positive effect on labour productivity suggesting that it would be prudent to tailor the market needs to the learning curriculum and embrace talents in schools or learning institutions. Better quality of the workforce shortens the learning curve and time period in acquiring of new technology (Jajri, 2007). A clear focus on the quality of education to achieve the vision 2030 is important. Such an education system would enormously recognize the usefulness of the technical skills and non-formal skills like mechanics. Besides, the Kenyan education system and job market does not reward the level of education that has significantly seen brain drain on the rise. Net gains can be made through maintenance of quality environment for learning, which can increase workplace productivity in graduates (McCowan, 2018). The capital per worker is seen to influence labour productivity positively. Acquisition and facilitation by aid of better and more efficient working equipment at the workplace is instrumental to long term improvement in labour productivity and improvement of social welfare.

5.3 Policy Implications

Continued state intervention in the education system is necessary to guarantee quality across the system. This can involve investment of public resources in the face of market failure, as well as equity and addressing issues of lack of incentives for instructors to focus on teaching excellence. Furthermore, better incentives and a reward system for educators needs to be reviewed to curb brain drain and guarantee quality in learning institutions.

There is need to develop a patent information policy, cut down on lengthy procedures and costs associated with patent application to create a conducive innovation environment - that will protect ideas of innovators and spur uptake of new technologies.

5.4 Limitations and Areas for Further Research

The study faced a few limitations, including availability of reliable data as in other developing countries. This was so exaggerated for the informal sector. This necessitated use of proxies or estimates for variables from international data sources. In this case this may affect the validity of the results especially in concluding for the informal sector which has the biggest share in the formal -informal sector divide of the economy. Secondly, studies on labour productivity in Kenya are still growing, and the study had to rely heavily on previous studies in more developed countries. Despite this, better methods of approximation could not be adopted to country specific needs due to again a limitation on data.

Since any study is inconclusive, in the first place, the period covered in this study, 2000-2016 is relatively short for more informed decisions to be reached when focus is laid on the principles of time series data. Future studies should attempt a longer span of time perhaps since independence. This will be useful in chatting a way forward in the contribution to labour productivity issues that remain at the helm of the development agenda of the republic of Kenya. On the same vein, coefficient on the constant term of the regression was statistically significant suggesting possible omission of other explanatory variables. Forthcoming studies could seek to incorporate variables that better explain labour productivity not used in this study.

The current government has prioritized the Big Four Agenda in its development Agenda that touch on food security and manufacturing. With a focus on agriculture, there is need to consider proposed tradeoffs between the sector and manufacturing. For example, it is argued that for industrialization or development, in the Dual-Economy models of Lewis (1954), labour must be shifted from agriculture to industry. The argument is that aggregate labour productivity is negatively impacted by allocating too many factors to the less productive agricultural sector (Vollrath, 2013), resulting from factor market inefficiencies within the economy, - lowering overall productivity and income (Vollrath, 2009).

Future work should attempt to find out if indeed such a transition can improve economy labour productivity in the realization that as a country the highest contribution to GDP (25 per cent) and more than 60 per cent of total employment is from Agriculture. And despite this the role of Agriculture may be here to stay, given the advent of natural uncertainties like drought and floods as well as the finding in this study that an increase in the share of labour in agriculture is important in increasing labour productivity.

Technology is important in increasing labour productivity in this study. It is noted that advanced technologies usually save the time leading to efficiency in labour use as well as reducing labour intensive activities. Since the motivation of this study

was which sectors are more productive and can be relied to create jobs, future work may explore the nexus between advanced capital-intensive technologies rather than labour intensive ones and employment creation. Doing so would reveal the relevance of the dual economy models of Lewis (1954) in economic transformation.

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Total Factor Productivity

Estimation of Total Factor Productivity (TFP) requires specification of the underlying production function. The production function is a mathematical expression that describes the systematic relationship between inputs and output in an economy. It also represents the technology of the firm. A simple production function is expressed as

$$Y = F(K, L) \ldots\ldots\ldots\ldots 6.1$$

Assuming production function takes the Cobb-Douglas form then 6.1 can be written as

$$Y = AK^{\alpha} L^{\beta} \ldots\ldots\ldots\ldots\ldots 6.2$$

The Cobb-Douglas is a special case of the production functions with constant elasticity of substitution. Although the assumption of constant elasticity is not very suitable for making forecasts in practice, it can still be used as one criterion for making a decision, based on past experience, about the realization of long-term plans (McCombie, Pugno, & Soro, 2002). In practice it will be influenced by various economic factors and it can be shown that under the normal assumptions of long-period analysis the elasticity assumes a mathematical form that tends to make it – within reasonable limits – fairly independent of variations in such economic factors.

In equation 6.2, α, is the elasticity of capital with respect to output, while β, is the elasticity of capital with respect to output. The assumption is that the Cobb Douglas production function is of constant returns to scale. Thus, the sum of the elasticities equals one $\alpha + \beta + 1$. Second, it is assumed that the parameters α and β, are greater than zero but less than unity. The level of technology A, is assumed to be positive ($A>0$). In addition, if markets are assumed to be competitive such that factors are paid their marginal product, then α and β can be interpreted as capital and Labour's share of output respectively (Miller E. , 2008).

The main advantage of these assumptions is simplicity. However, these assumptions seem broadly consistent with empirical evidence at the macro level. The unit elasticity assumption is consistent with the relative constancy of nominal factor shares (D'Auria, et al., 2010). Also, there is little empirical evidence of substantial increasing/decreasing returns to scale (Burnside, Eichenbaum, & Rebelo, 1995)

Appendices

Figure A1: Line plot of log of labour productivity

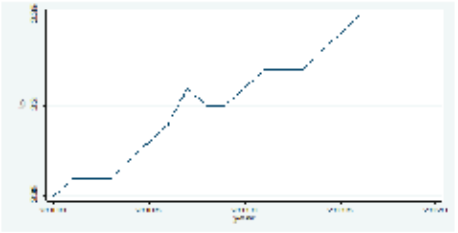


Figure A2: Line plot of log of wages

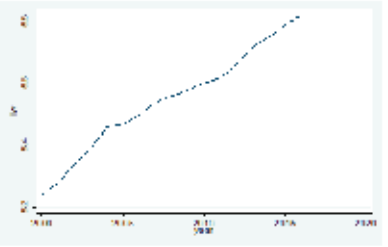


Figure A3: Line plot of log of health

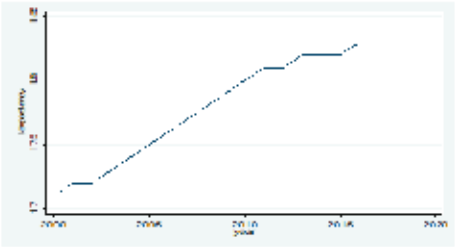


Figure A4: Line plot of log of education

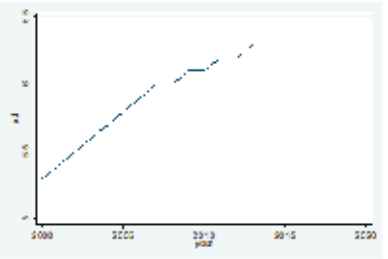


Figure A5: Line plot of governance

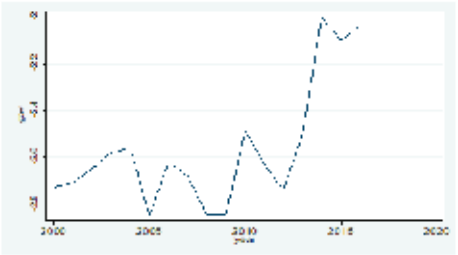


Figure A6: Line plot of TFP

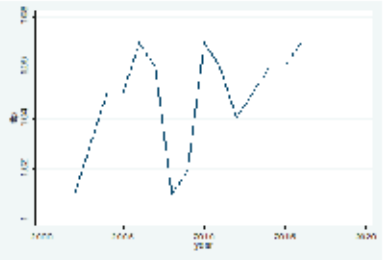


Figure A7: Line plot of log of capital intensity

Figure A8: Line plot of political stability

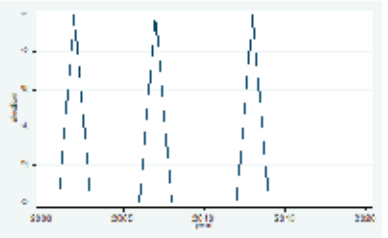


Figure A9: Line plot of log of ICT

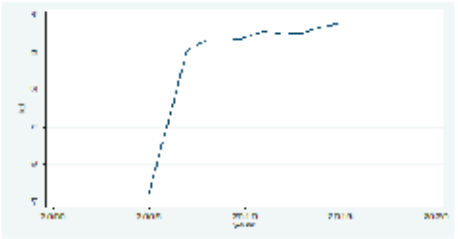


Figure A10: Line plot of agricultural share in GDP

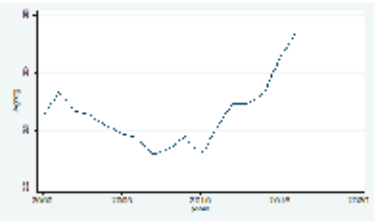


Figure A11: Line plot of services share in GDP

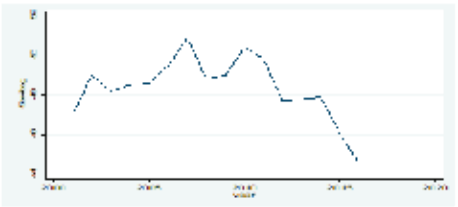


Figure A12: Line plot of manufacturing share in GDP

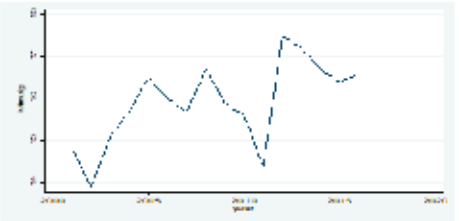


Figure A13: Line plot of share of labour in agriculture

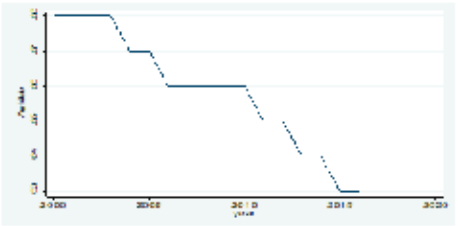


Figure A14: Line plot of share of labour in manufacturing

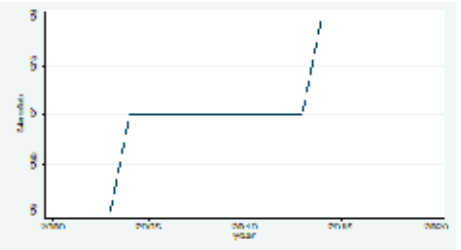


Figure A15: Line plot of share of labour in services

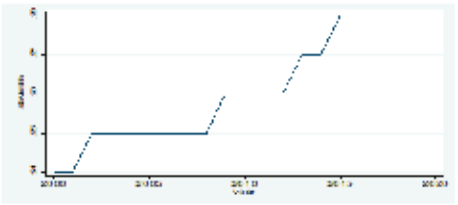


Figure A16: Line plot of share of macro stability

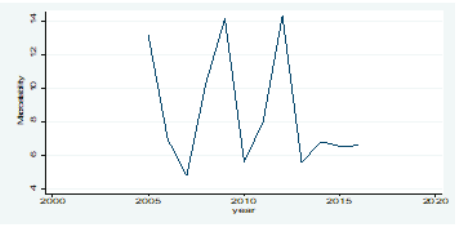


Figure A17: Line plot of openness

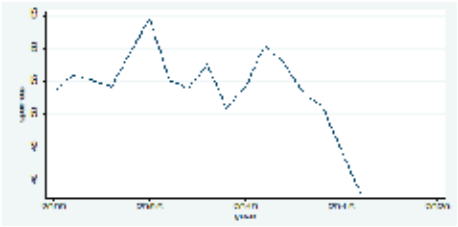


Figure A18: Line Plot of log of government expenditure

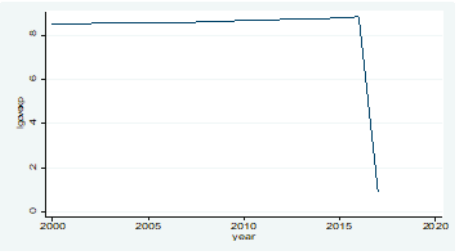
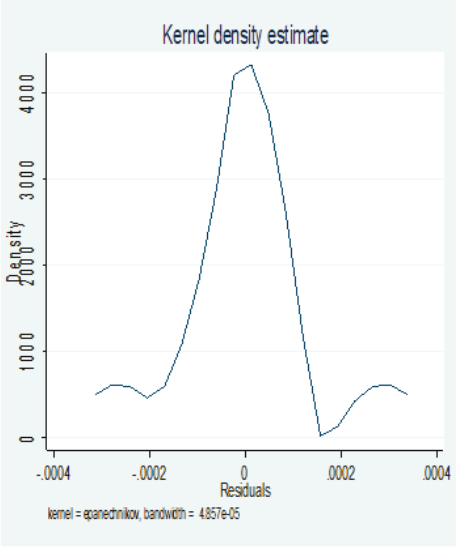


Figure A19: Serial correlation tests plots



Estimating 6.2 requires linearizing using logarithm to obtain 6.3. Transforming 6.2 into log linear form, enables the parameters to be estimated. The model adopted in this study as shown by equation 6.3 is the revised form of conventional Cobb-Douglas production function used order to estimate TFP.

$$log\ Y = log\ A + \alpha\ log\ K + \beta\ log\ L \ldots\ldots\ldots\ldots\ 6.3$$

In this model, *A* represents the TFP coefficient. Running logarithm at both sides of the equation ensures that inputs can be split easily, in the production of output (Armagan & Ozden, 2007) During logarithmic transformation, whenever there are variables that include zero, one should be added to such variables, to accomplish the transformation. The independent variables in the model were taken as capital stock (*K*) and Number of persons in employment (*L*). The dependent variable was taken as gross value added (*Y*) at the sector level and at the economy level.

The Cobb- Douglas specification has over a long time been popular among economists because it is easy to work with, flexible and gives simple closed-form solutions to many economic problems. It can also be used to test production flexibilities statistically and to obtain sufficient number of degree of freedom even where data is very few. In empirical studies, the Cobb-Douglas has been able to produce reasonably accurate long-term economic forecasts (Miller E. , 2008). Equation 6.4 was used in estimating multifactor productivity

$$log\ A = log\ Y - \alpha\ log\ K - \beta\ log\ L \ldots\ldots\ldots\ldots\ 6.4$$

Table A1: Results for Cobb-Douglas regression with constant returns to scale constrained linear regression

Log of GVA	Coefficient	Standard error	t-value	P-Value
Log of labour	0.862	0.146	58.97	0
Log of capital	0.137	0.146	9.42	0
Constant	4.842	0.483	100.35	0
Number of observations =17				
Root MSE = 0.028				

Table A2: Computation of Total Factor productivity

Year	Log A	Log Y	Log K	a*logK	Log L	b*log L	MFP
2000	4.785	14.453	12.101	1.667	9.279	8.001	119.676
2001	4.818	14.502	12.129	1.671	9.294	8.013	123.719
2002	4.820	14.509	12.067	1.662	9.310	8.027	123.956
2003	4.847	14.540	11.984	1.651	9.327	8.042	127.408
2004	4.857	14.579	12.054	1.661	9.349	8.061	128.684
2005	4.856	14.630	12.299	1.695	9.370	8.079	128.516
2006	4.860	14.684	12.469	1.718	9.402	8.107	128.985
2007	4.876	14.745	12.595	1.735	9.433	8.134	131.102
2008	4.846	14.756	12.688	1.748	9.465	8.161	127.270
2009	4.848	14.781	12.715	1.752	9.489	8.181	127.465
2010	4.864	14.835	12.790	1.762	9.521	8.210	129.521
2011	4.869	14.888	12.908	1.778	9.557	8.240	130.221
2012	4.801	14.928	13.473	1.856	9.593	8.271	121.592
2013	4.820	14.981	13.494	1.859	9.628	8.302	123.926
2014	4.826	15.035	13.627	1.877	9.664	8.332	124.656
2015	4.845	15.094	13.692	1.886	9.699	8.363	127.102
2016	4.881	15.153	13.594	1.873	9.741	8.399	131.752

The computation of TFP is based on the equation 3.5. The factor shares for capital and labour were used to come up with the figures suggested by this graph.

Figure A20: Multifactor Productivity ignoring stationarity tests

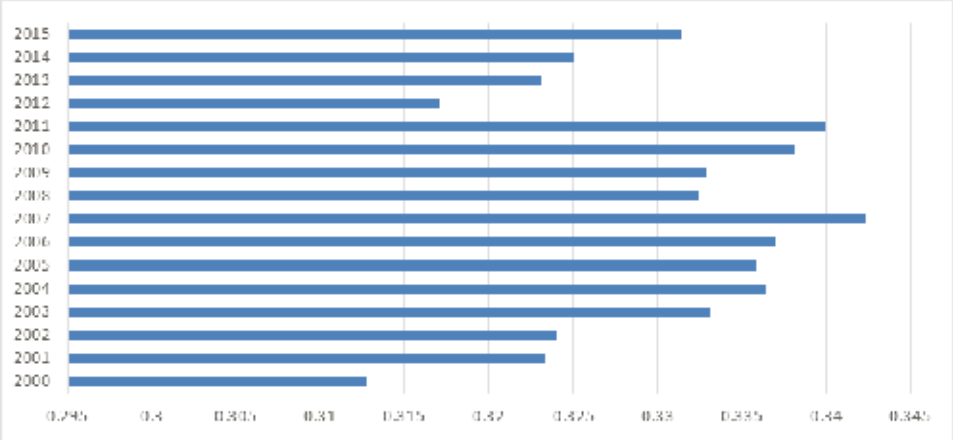
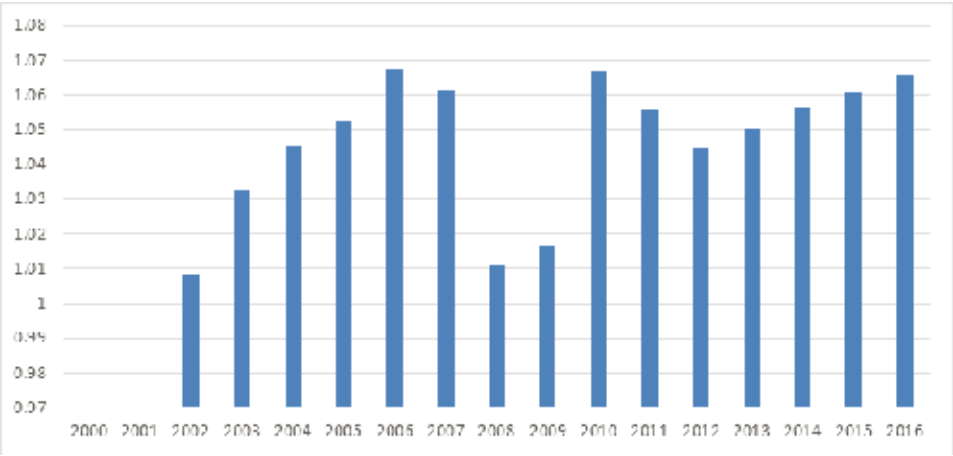


Figure A21: TFP using differenced variables and regression restriction



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